Application of nano/microparticles on asphalt mixes to promote photocatalysis and superhydrophobicity

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ABSTRACT

The integration of nano/microparticles in asphalt mixtures provides new capabilities (functionalization) such as: photocatalytic; superhydrophobic and self-cleaning, which can contribute to the mitigation of present public health problems as air pollution and road safety. Thus, the main goal of this research was to develop these capabilities on asphalt mixtures composed of raw and recycled materials and analyze the performance of an improved functionalization process using a resin spraying for the immobilization of the particles. Solutions composed of nanoparticles of titanium dioxide (nano-TiO_2) and/or microparticles of polytetrafluoroethylene (micro-PTFE) and water, ethyl alcohol, and dimethyl ketone as solvents were produced and subsequently sprayed over a conventional AC 10. The best solution (BS) to proceed with the functionalization process was selected after the evaluation of the samples under dye degradation and wettability. Next, two successive spraying coatings were carried out over conventional and recycled AC 10 with Reclaimed Asphalt Pavement (RAP) and Steel Slags (SS): the first one with a diluted epoxy resin and the second one with the BS. In the first step of the functionalization process, the BS selected was composed of TiO_2 (4 g/L) and PTFE (4 g/L) under an ethyl alcohol medium. The next steps showed that by increasing the amounts of resin, the photocatalytic efficiency decreases and the wettability increases, performing better for 0.25 g of resin with BS. All the mixtures achieved the superhydrophobicity property (water contact angle higher than 150°) and performed similarly regarding wettability with the lowest resin amount. Nevertheless, the conventional AC 10 presented the best results concerning photocatalysis. These functionalized pavement surfaces can degrade gases like SO_2 and NO_x, avoid accidents by removing the small dirt particles, degrade oils on the pavement surface, presenting great benefits to road safety and the environment. Multifunctional asphalt mixtures can be included in the sphere of Clean Technologies, and, in this framework, they contribute to the transition to the sustainable model "Green Recovery". Moreover, this research presents a potential destination for the nano/micromaterials, the Civil Engineering fields, and, if incorporated on a large scale, can stimulate the dynamism of industry.

Keywords: smart asphalt mixtures, photocatalytic asphalt mixtures, superhydrophobic asphalt mixtures, functionalization process, sustainable road pavements.